

# (12) UK Patent Application (19) GB (11) 2 381 952 (13) A

(43) Date of A Publication 14.05.2003

(21) Application No 0127208.7

(22) Date of Filing 13.11.2001

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(51) INT CL<sup>7</sup>

H01Q 1/24, H04B 1/38

(52) UK CL (Edition V )

H1Q QKA

(56) Documents Cited

GB 2289163 A  
WO 2001/037366 A1

EP 0856906 A2  
US 5838285 A

(58) Field of Search

UK CL (Edition T ) H1Q QDN QKA QKE

INT CL<sup>7</sup> H01Q 1/08 1/24 1/38 9/04 11/14, H04B 1/38

Other: Online: WPI, EPODOC, PAJ

(54) Abstract Title

Flexible substrate antenna for mobile telephone

(57) An antenna 1, for use with a mobile communication device 7, comprises a generally laminar, flexible ribbon-like dielectric substrate 2 having a ground plane 6 formed on one surface and a conductive antenna 1 pattern 3 on the other surface. When the device 7 is held by a user in an operating position, the antenna 1 hangs over the back of the user's hand, and thus the antenna pattern 3 faces away from the user's head. The antenna is therefore said to provide a low specific absorption rate (SAR). The antenna pattern 3, which is printed, sputtered or electrodeposited onto the flexible substrate 2, may be a microstrip and take many forms e.g. monopole, dipole, spiral, loop, patch, bow-tie, meander. More than one pattern may be provided, for diversity or multi-band applications.

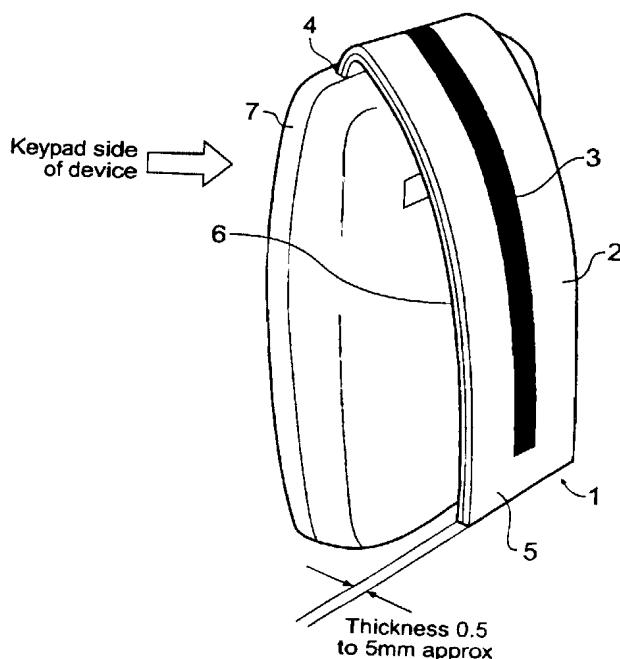


Fig. 1

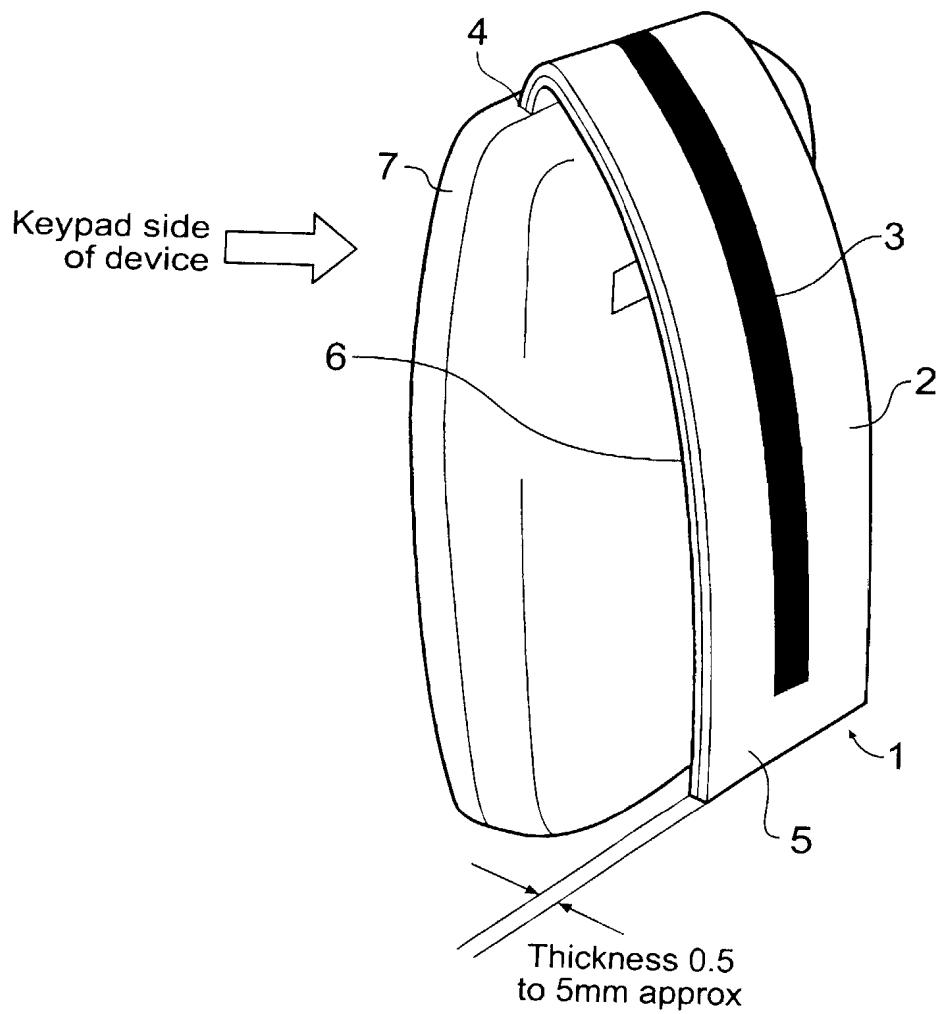


Fig. 1

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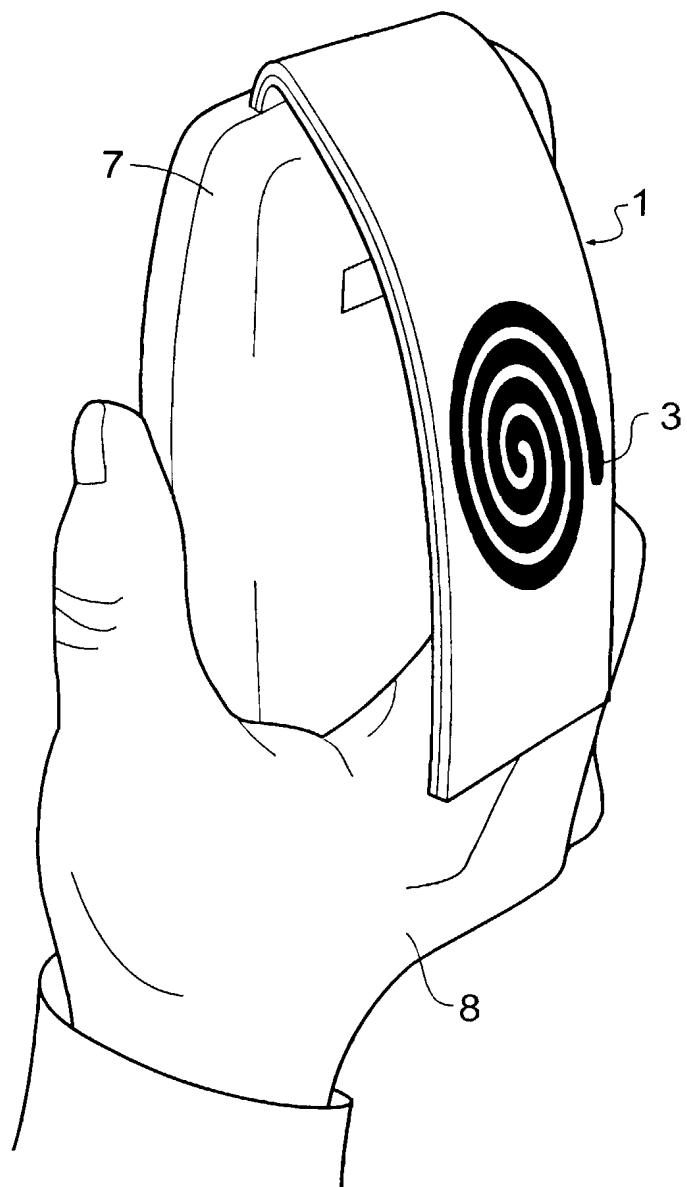


Fig. 2

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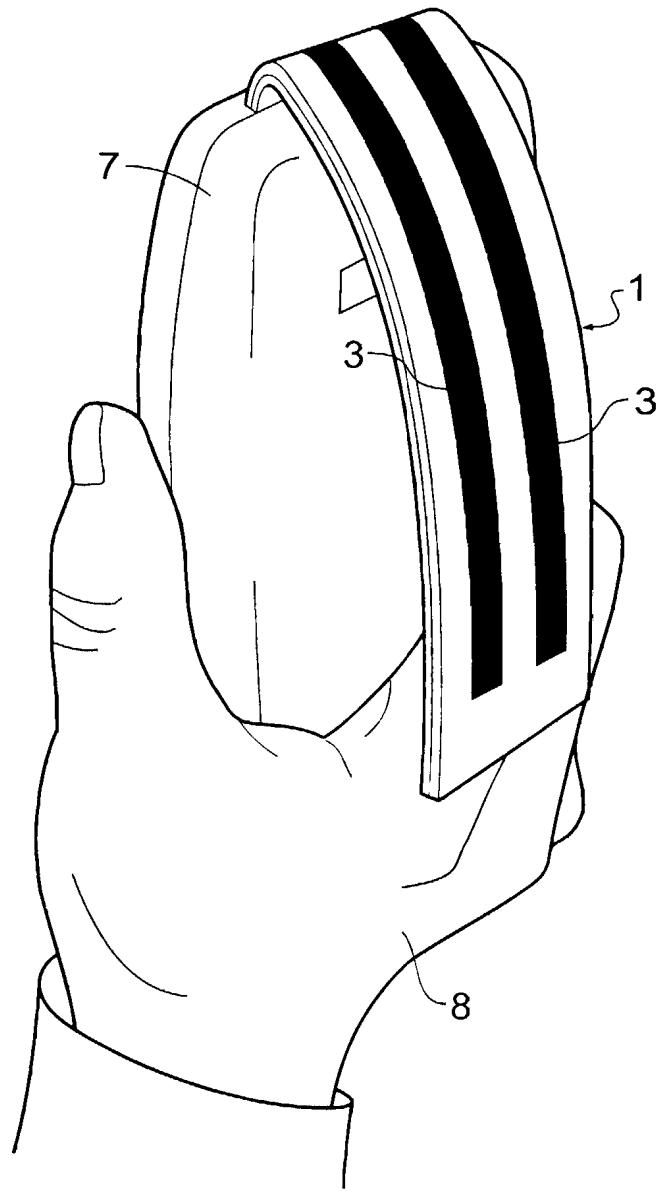


Fig. 3

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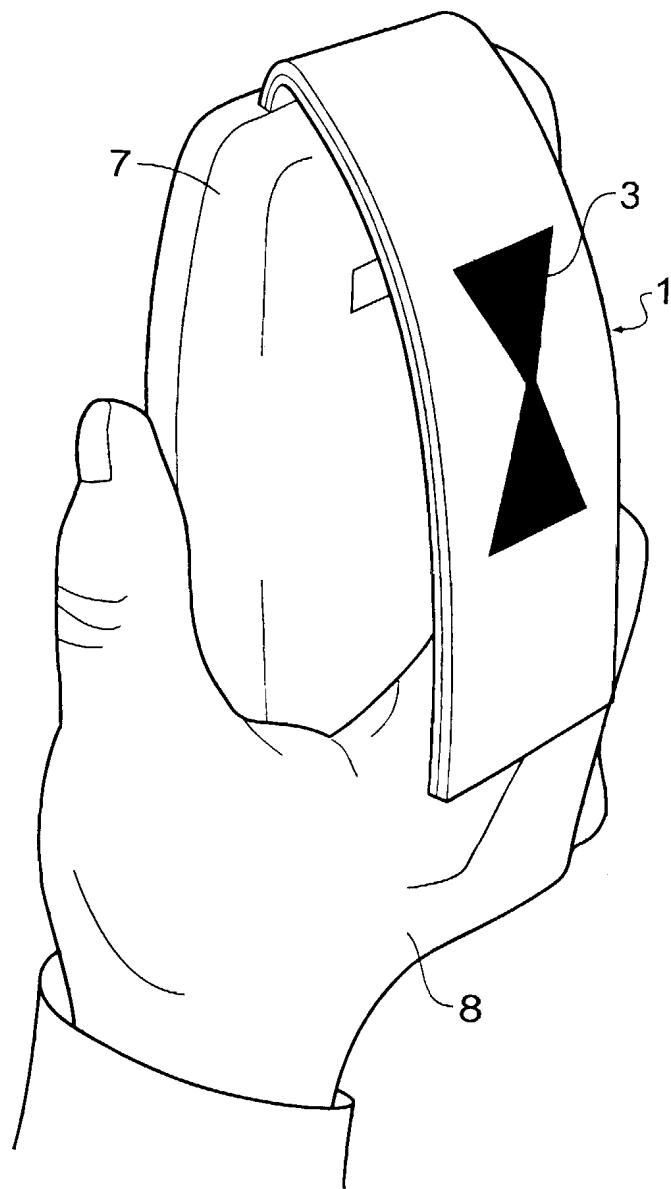


Fig. 4

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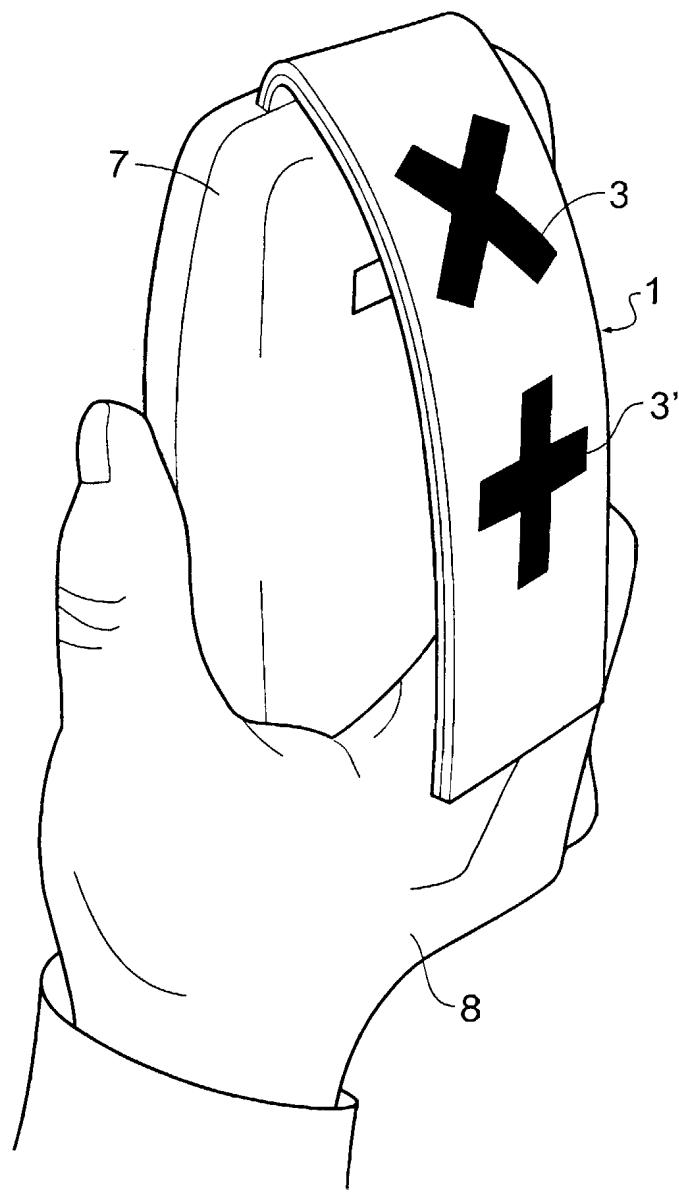


Fig. 5

IMPROVEMENTS RELATING TO ANTENNAS

5 The present invention relates to antennas, in particular but not exclusively antennas for mobile telephone handsets, which have a low specific absorption rate in relation to radiation emitted therefrom in the direction of a user's head.

10 Mobile radio telephones, such as those using the GSM system, have become extremely popular in recent years. These telephones generally operate using the microwave part of the electromagnetic spectrum, typically at frequencies in the range of 900 to 2300MHz, although higher frequencies are being used more and more with broadband and "3G" (third generation) services.

15 Although the radiation emitted by mobile telephones is generally thought to be of fairly low power, there has been concern as to possible detrimental health effects when mobile telephones are used. This is because most mobile telephone antennas radiate in many directions, some of which are towards the head and hand of a user. Often, a user's head, hand and/or shoulder absorbs a large part (up to 40%) of the power emitted by a mobile telephone antenna, and although there is no conclusive 20 evidence that this is harmful, there is a perceived risk.

25 Radiation emitted from mobile telephones is generally tested in the laboratory by setting up a replica human head including appropriate detectors and then placing a mobile telephone at the side of the replica head while measuring radiation absorbed thereby. The industry standard measure is the specific absorption rate (SAR), and there are currently plans for handset manufacturers to label the packaging of their products with SAR figures so as to give the public some degree of information as to the levels of radiation emitted. It is therefore of significant commercial interest to provide an antenna for a mobile telephone handset that gives rise to low or near-zero 30 SAR.

According to a first aspect of the present invention, there is provided an antenna for a mobile telephone handset, the antenna comprising a flexible conductive groundplane formed on a first side of a flexible dielectric substrate and at least one flexible conductive antenna element formed in the substrate or on a second side thereof opposed to the first, wherein the antenna is adapted for connection to a handset in such a way that, when the handset is held against a user's head in a normal speaking position, the substrate is positionable such that the second side thereof faces away from the user's head.

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10 Preferably, the substrate (when connected to a handset) is positionable so as to pass over the back of a user's hand when the user holds the handset to his or her head in such a way that the antenna is separated from the user's head by the user's hand.

According to a second aspect of the present invention, there is provided an antenna for a mobile communications device, the antenna comprising a flexible conductive groundplane formed on a first side of a generally laminar, flexible, ribbon-like dielectric substrate and at least one flexible conductive antenna element formed in the substrate or on a second side thereof opposed to the first.

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20 The ribbon-like dielectric substrate is advantageously adapted for connection to a part of a mobile communications device handset so that it will tend to drape over the back of a user's hand when the handset is held to the user's head in normal use, the second side of the substrate facing away from the user's head. The part of the handset to which the substrate is adapted for connection may be a rear part of a handset casing, or may be any other appropriate part.

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According to a third aspect of the present invention, there is provided a mobile telephone handset having an antenna in the form of a flexible conductive groundplane formed on a first side of a flexible dielectric substrate and at least one flexible conductive antenna element formed in the substrate or on a second side thereof opposed to the first, the substrate being connected to the handset in such a

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way that, when the handset is held against a user's head during use, the second side of the substrate faces away from the user's head.

5 Preferably, the substrate is positionable so as to pass over the back of a user's hand when the user holds the handset to his or her head in such a way that the antenna is separated from the user's head by the user's hand.

The present invention is based upon the fact that it is not necessary for a handset antenna to have a line-of-sight to a base station antenna because of scattering effects 10 (including reflection and diffraction) caused by buildings and other structures which tend to be part of the urban and suburban environment in which handsets are generally used. This scattering means that signals transmitted from the handset antenna need not initially be aimed in the direction of the nearest base station, but will tend to reach the base station antenna by virtue of reflection and scattering in 15 many directions. Accordingly, it is not necessary for a handset antenna to be an omnidirectional (i.e. non-directional) antenna as is commonplace with existing handsets. Instead, an antenna with any directional radiation pattern may be employed on a mobile handset. Suitable radiation patterns include general hemispherical, 20 cartoid and unidirectional, with or without perturbations, or other directional shapes.

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By generating these radiation patterns with the present invention, radiation can be directed generally away from a user's head/hand/shoulder, thus giving a low or near-zero SAR, while still allowing effective communication with a base station antenna (this possibly being assisted by scattering effects caused by buildings and other large 25 structures). Furthermore, by encouraging a user to position the antenna so that it is separated, in use, from the user's head by the user's hand, it is possible to provide additional shielding of the user's head from radiation that may interact more readily with brain and/or eye tissue than with tissue in the user's hand.

30 Preferably, the conductive antenna element of the antenna is printed, sputtered or electrodeposited onto one side of the flexible dielectric substrate, or may be

5 embedded therein. The conductive element may be formed as a microstrip, and may have a monopole, dipole, spiral, ring, loop, patch, bow-tie, meander, zig-zag, Yagi, slot, post, fractal, triangular or circular configuration or arrays of such configurations. A suitable material for the conductive element is copper, although other conductive materials may be equally suitable.

10 Where more than one conductive element is provided on the flexible dielectric substrate, the elements may be oriented in different directions so as to provide antenna diversity (which can reduce drop-outs) and possible direction finding capability. Furthermore, by providing more than one conductive element and by choosing the shape, configuration and material of the conductive elements appropriately, a multi-band antenna having more than one resonant frequency may be obtained.

15 The flexible dielectric substrate and the conductive elements may be sufficiently flexible so as to hang or drape freely under gravity. In other words, the flexible dielectric substrate may be made of a thin plastics or other dielectric material which flexes freely in the manner of a flag or pennant.

20 Alternatively, the flexible dielectric substrate may have sufficient stiffness so as to hold a given spatial configuration when flexed. In such embodiment, the substrate may take the form of a flexible part of a housing for a mobile telephone or other communications equipment such as a personal digital assistant (PDA), laptop computer or other devices.

25 The antenna of the present invention may be connected at one or both ends to a mobile telephone or other communications device. In general, the antenna and substrate will have a surface area similar in size to a surface area of a mobile telephone to which it is or may be attached.

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For a better understanding of the present invention and to show how it may be carried into effect, reference shall now be made by way of example to the accompanying drawings, in which:

5 FIGURE 1 shows a first embodiment of an antenna of the present invention fitted to a mobile telephone handset;

FIGURE 2 shows a second embodiment of an antenna of the present invention fitted to a mobile telephone handset;

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FIGURE 3 shows a third embodiment of an antenna of the present invention fitted to a mobile telephone handset;

15 FIGURE 4 shows a fourth embodiment of an antenna of the present invention fitted to a mobile telephone handset; and

FIGURE 5 shows a fifth embodiment of an antenna of the present invention fitted to a mobile telephone handset.

20 Figure 1 shows an antenna 1 comprising a thin, flexible, ribbon-like dielectric substrate 2 having a flexible conductive groundplane 6 formed on a first side thereof and a flexible conductive copper microstrip 3 printed on a second side thereof opposed to the first. The microstrip 3 extends all the way to one end 4 of the substrate 2, but stops short of the other end 5. The end 4 of the substrate is adapted  
25 for connection to a handset 7 of a mobile telephone or other communications device, with the microstrip 3 being adapted for electrical connection to an antenna output thereof. The antenna 1 is flexible enough so as to tend to drape over the back of a user's hand when the handset 7 is held to the user's head in normal use, with the microstrip 3 being separated from a user's head by the groundplane 6.

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The antenna 1 preferably has an overall thickness of 0.5mm to 5mm. The substrate 2, microstrip 3 and groundplane 6 are preferably configured so that the antenna 1 as a whole is flexible in the manner of a ribbon.

5 Figure 2 shows a first alternative antenna 1 configuration, wherein the microstrip 3 is formed as a spiral. One end of the spiral microstrip 3 is electrically connected to an antenna output of the handset 7. It can be seen how the antenna 1 tends to drape over the back of a user's hand 8 when the handset 7 is in normal use, with the microstrip 3 facing away from the user's head.

10 Figure 3 shows a second alternative antenna 1 configuration, wherein there is provided a pair of substantially parallel microstrips 3. One end of each microstrip 3 is electrically connected to an antenna output of the handset 7. It can be seen how the antenna 1 tends to drape over the back of a user's hand 8 when the handset 7 is in normal use, with the microstrips 3 facing away from the user's head.

15 Figure 4 shows a third alternative antenna 1 configuration, wherein the microstrip 3 is formed in a bow-tie configuration. The microstrip 3 is electrically connected to an antenna output of the handset 7. It can be seen how the antenna 1 tends to drape over the back of a user's hand 8 when the handset 7 is in normal use, with the microstrip 3 facing away from the user's head.

20 Figure 5 shows a fourth alternative antenna 1 configuration, wherein there is provided a pair of cruciform microstrips 3, 3' arranged at 45° to each other. The microstrips 3, 3' are electrically connected to an antenna output of the handset 7. It can be seen how the antenna 1 tends to drape over the back of a user's hand 8 when the handset 7 is in normal use, with the microstrips 3, 3' facing away from the user's head. Because the cruciform microstrips 3, 3' are oriented at 45° to each other, they have improved sensitivity to signals from a wide range of incident directions.

**CLAIMS:**

1. An antenna for a mobile telephone handset, the antenna comprising a flexible conductive groundplane formed on a first side of a flexible dielectric substrate and at least one flexible conductive antenna element formed in the substrate or on a second side thereof opposed to the first, wherein the antenna is adapted for connection to a handset in such a way that, when the handset is held against a user's head in a normal speaking position, the substrate is positionable such that the second side thereof faces away from the user's head.  
10
2. An antenna for a mobile communications device, the antenna comprising a flexible conductive groundplane formed on a first side of a generally laminar, flexible, ribbon-like dielectric substrate and at least one flexible conductive antenna element formed in the substrate or on a second side thereof opposed to the first.  
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3. An antenna as claimed in any preceding claim, wherein the antenna has a thickness of 5mm or less.
4. An antenna as claimed in claim 3, wherein the antenna has a thickness of 20 2mm or less.
5. An antenna as claimed in any preceding claim, wherein the substrate is sufficiently flexible so as to hang or drape freely under gravity.
- 25 6. An antenna as claimed in any preceding claim, having a low or near-zero measured specific absorption rate on the first side of the substrate behind the groundplane during operation of the antenna.
- 30 7. An antenna as claimed in any preceding claim, wherein a plurality of conductive antenna elements is provided in the substrate or on the second side thereof.

8. An antenna as claimed in claim 7, wherein the conductive antenna elements have different orientations in or on the substrate.

5 9. A mobile telephone handset having an antenna in the form of a flexible conductive groundplane formed on a first side of a flexible dielectric substrate and at least one flexible conductive antenna element formed in the substrate or on a second side thereof opposed to the first, the substrate being connected to the handset in such a way that, when the handset is held against a user's head during use, the second side 10 of the substrate faces away from the user's head.

10. A handset as claimed in claim 9, wherein the substrate is positionable so as to pass over the back of a user's hand when the user holds the handset to his or her head in such a way that the antenna is separated from the user's head by the user's hand.

15 11. A mobile communications device fitted with an antenna as claimed in any one of claims 1 to 8.

12. An antenna substantially as hereinbefore described with reference to the 20 accompanying drawings.

13. A mobile telephone handset substantially as hereinbefore described with reference to the accompanying drawings.



Application No: GB 0127208.7  
Claims searched: all

Examiner: Stephen Jennings  
Date of search: 28 February 2002

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.T): H1Q (QKA, QKE, QDN)

Int Cl (Ed.7): H01Q (1/08, 1/24, 1/38, 9/04, 11/14), H04B (1/38)

Other: Online: WPI, EPODOC, PAJ

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
X	GB 2289163 A (Quantum Communications Group) See figure 2, page 4 lines 23-28, page 6 lines 5-17	2-4,11
X	US 5838285 (Motorola, Inc) See figures 1 and 2, column 2 lines 27-35	2,7,11
X	WO 01/37366 A1 (Motorola, Inc) See figure 2, page 5 lines 11-16	2
X	EP 0856906 A2 (ICO Services Ltd)	2,7,11

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.